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SCARIFIER

The present invention relates to a tractor mounted  
scarifier and a pedestrian scarifier used for cutting turf  
5 surfaces.

BACKGROUND OF THE INVENTION

It is widely recognised that rigorous turf maintenance  
10 practices are essential in maintaining healthy growing  
turf surfaces. Such practices as aerification,  
topdressing, verticutting and dethatching are important in  
maintaining good grass surfaces particularly for fine  
sports surfaces such as golf greens or cricket pitches.

15 Organic matter in the form of old roots and other plant  
matter accumulates in the upper portion of the soil  
profile. This accumulation can alter the balance of pore  
space which in turn reduces the rate of soil oxygenation  
20 and results in an inferior turf surface. Managing the  
physical properties of the soil in the upper portion of  
the soil profile is essential in maintaining healthy  
grass. Dethatching by verticutting physically removes  
organic matter by using a blade to cut a path into the  
25 surface profile to bring organic matter to the surface and  
to aerate the ground. The process usually also includes  
topdressing the soil after dethatching with sand and/or  
seed mixture.

30 A scarifier physically removes organic matter by  
dethatching. One type of scarifier is a verticutter  
having spaced circular blades that rotate to cut grooves  
in the turf as the scarifier machine moves forward. The  
blades rotate to raise thatch, stolons and other organic  
35 materials in the machine's wake. The blades can either  
rotate or counter-rotate to the direction of the moving  
scarifier. The resulting grooves open up the turf for top

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dressings, seeding or other operations. The grooves also allow better water and air exchange in the turf soil surface.

5 After drawing the accumulated organic matter to the surface of the turf, the matter is removed by using shovels, rakes, larger shoveling machines and/or blowers. The grooves can then be filled with top dressing in the form of sand or seeding mixture.

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While this maintenance process is effective in maintaining good health of the grass layer the process is time consuming. Additionally, a playing green is put out of use for the time it takes to aerificate, dethatch and  
15 topdress the green. The green is also usually unable to be used for part of the recovery process thereafter, which takes up to two weeks.

A more efficient and easier to use scarifier is required  
20 for aerificating turf.

#### SUMMARY OF THE INVENTION

In one embodiment the invention provides a scarifier for  
25 cutting turf comprising a frame supported on wheels, a plurality of circular cutting blades co-axially mounted on a rotor shaft supported by the frame, driving means to drive the rotor shaft and rotate the blades, and adjustment means for adjusting the relative position of  
30 the wheels and the rotor shaft, thereby adjusting the height of the rotor shaft off the ground.

In another embodiment the invention provides a scarifier for cutting turf comprising a frame supported on wheels, a  
35 plurality of circular cutting blades coaxially mounted on a rotor shaft supported by the frame, driving means to drive the rotor shaft and rotate the blades, and

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adjustment means for adjusting the position of each wheel relative to the frame, thereby adjusting the height of the rotor shaft off the ground.

5 The wheels are preferably co-dependently attached to the frame by a linkage operable from one or two control points. The control points are preferably a screw handle threaded in a bore and rotatable in the bore against a reaction surface wherein the bore is fixed to the linkage.

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The linkage preferably comprises: a pivot bar extending across the frame and journalled thereto at its end, the bore being fixed to the pivot bar; a first curved arm attached at one end to the pivot bar and at the other end to a first wheel; and a linking member connected at one end to pivot with the pivot bar and at the other end to pivot with a second curved arm which supports a second wheel, so that the vertical positioning of the first and second wheels are simultaneously adjusted.

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There are preferably two pairs of front and rear wheels, each pair being supported by curved arms where the curved arms are linked by a linking member pivotally attached to the pivot bar, and wherein one wheel is securely fixed to the pivot bar.

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The drive means preferably comprises a belt drive driven by pulley shafts that are powered through a gear box by a drive shaft.

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The scarifier is preferably connectable to a tractor having a motor thereon to drive the drive shaft.

In a further embodiment the invention provides a scarifier for cutting turf comprising a frame supported on wheels, a plurality of circular cutting blades co-axially mounted on a rotor shaft mounted to an elongate rotor housing, the

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rotor housing being attached to the frame, but independently movable relative thereto, driving means to drive the rotor shaft and rotate the blades, and adjustment means for adjusting the height of the rotor housing relative to the frame.

The drive means preferably includes two belt drives connected in series having in common an intermediate pulley mounted on an intermediate shaft, wherein the rotor housing is pivoted at the intermediate shaft to move relative to the frame.

The movement of the rotor housing is preferably actuated by an operating lever connected to the housing through a linkage.

Preferably, the rotor housing is supported at its ends by rotor wheels. The rotor wheels are pivotally movable relative to the rotor housing to adjust the cutting depth of the blades. Preferably, a rotor housing adjustment mechanism adjusts the relative height of the rotor wheels relative to the blades.

The frame is preferably mounted on four support wheels. The scarifier preferably has a motor that drives the blades and the support wheels, and a drive lever is operable to hydrostatically drive one or more support wheels at variable speeds.

In this embodiment the scarifier is a pedestrian controlled scarifier and has a handle extending diagonally upward to steer the scarifier. The handle supports the operating and drive levers.

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BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention are described further by way of example with reference to the accompanying  
5 drawings of which:

Figure 1 is a perspective rear view of a tractor  
mounted scarifier according to the present invention with  
covers removed;  
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Figure 2 is a closer cut-out perspective view of the  
wheel adjustment mechanism of the scarifier of Figure 1;

Figure 3 is a right side perspective view of a  
15 pedestrian scarifier in accordance with an embodiment of  
the present invention;

Figure 4 is a left side perspective view of the  
pedestrian scarifier illustrated in Figure 3;  
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Figure 5 is a sectional side view of the pedestrian  
scarifier of Figure 3 with the rotor housing in the raised  
position;

25 Figure 6 is a similar view to Figure 5 but with the  
rotor housing in the lowered position; and

Figure 7 is a close perspective side view of the  
rotor housing of the pedestrian scarifier.  
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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings illustrate two types of scarifiers, namely a  
tractor mounted scarifier 10 and a pedestrian scarifier  
35 20.

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The tractor mounted scarifier 10 is illustrated in Figures 1 and 2 and has an elongate frame 11 constructed in welded steel. A housing 12 houses the operating internal components of the scarifier, all of which are mounted on four wheels 13. Scarifier 10 is mounted to the rear of a tractor by conventional hitching means. The scarifier is PTO (Power Take-Off) powered by the tractor through a drive shaft (not shown) that couples with a gear box 14 mounted on the scarifier frame 11.

As illustrated in Figure 1 gear box 14 drives two opposing pulley shafts 15 that extend from opposite sides of the gear box to the far ends of the scarifier frame 11. The pulley shafts 15 are supported in recesses 30 at the far ends of frame 11. Pulley wheels 16 attached at the end of each pulley shaft 15 drives a rotor shaft 18 by way of belt 17. Rotor shaft 18 extends along the underside of scarifier 10 and is driven at both ends by the pulley and belt arrangements. A number of spaced circular blades 19 (Figure 2) are mounted on rotor shaft 18. The blades rotate vertically about the horizontal rotor shaft to produce a vertical cut groove in the turf.

In this embodiment the blades are 210mm diameter hardened blades with a 30mm spacing between each blade. The spacing may vary depending on application between 5mm and 100mm. The preferred blades are quite thin, at 2mm, to avoid leaving large grooves in the turf. However, blades between 1mm and 3mm thickness can be usefully employed.

The cutting depth of the blades can be adjusted by adjusting the relative height of the wheels 13 to the frame 11. The depth of the cut generally ranges between 0 and 45mm, but may be deeper in some applications.

All four wheels are interlinked by an adjustment linkage mechanism 31 that provides for mutual raising and lowering

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of all four wheels 13 relative to the frame from one or two control points. The control points are namely adjusting handles 32. The adjustment mechanism 31 is illustrated more closely in Figure 2.

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A trailing pivot shaft 33 is rotatably mounted at its ends to fixed cross bars 34 which are fixed to frame 11. A pair of front and rear wheels 13a and 13b respectively are operably connected through a linkage system to each end of  
10 pivot shaft 33.

The two adjusting handles 32 are each provided with an externally threaded shaft 35 which turns in a bore 36 having a corresponding inner thread. Bore 36 is securely  
15 attached to pivot shaft 33 through connecting piece 37 such that bore 36 moves with and around pivot shaft 33. A reaction plate 40 adjacent bore 36 provides a reaction surface for the threaded shaft 35 when it extends through to the other side of bore 36.

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The weight of the wheels and of the linkage mechanism 31 is such that the end of threaded shaft 35 protruding through bore 36 is usually in abutment with plate 40. A curved "S" shaped rear arm 41 is fixedly mounted near each  
25 end of pivot shaft 33 and extends rearwardly. Each rear arm 41 supports at its end a rear wheel 13b. Therefore, as the handles 32 are rotated against plate 40, bore 36 moves up or down threaded shaft 35 of each handle to rotate pivot shaft 33 and directly raise or lower the rear  
30 wheels 13b. The handles are spaced sufficiently close to enable simultaneous rotation of the handles by one person. The handles can alternatively be rotated alternately in increments.

35 In a preferred embodiment, two handles are dependently used for lowering the wheels so as to avoid twisting and warping of the pivot shaft 33. However, it is possible to

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construct the scarifier with only one operating handle located centrally or to one side of pivoting shaft 33. This would be achieved by, for example, forming pivoting shaft 33 from a thicker gauge metal to give it more strength.

Rotating the handle 32 illustrated in Figure 2, for example, in the clockwise direction will move bore 36 away from the reaction plate 40 thereby pivoting pivot shaft 33 to lower rear wheels 13b relative to the frame 11. Both handles are simultaneously rotated, or alternately rotated in increments, to lower the wheels. Fine adjustment in levelling the blades to the ground requires independent adjustment of the handles.

The relative height of each front wheel 13a is simultaneously adjusted with the movement of the corresponding rear wheel 13b. A linkage arm 42 is pivotally attached to an enlarged segment 43 at an upper end of rear arm 41 defining one end of the "S" shape. Linkage arm 42 extends from the rear of the scarifier parallel with crossbar 34 to the front of the scarifier to be pivotally connected at its other end to a roughly "C" shaped curved front pivoting arm 44. Linkage arm 42 is pivotally mounted at an end of the "C"-shaped front arm. The other end of the front arm 44 provides a hub support for the front wheel 13a.

Spaced a short distance from the pivot connection with linkage arm 42 on front arm 44 is a pivot pin 45 pivotally securing front arm 44 to fixed crossed bar 34.

The above arrangement of linking front wheel 13a to the rear arm 41 allows simultaneous lowering of both the front and rear wheels. For example, rotating handle 32 in a clockwise direction as illustrated in Figure 2 will cause curved rear arm 41 to pivot at its connection with pivot

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shaft 33 to lower rear wheel 13b. This movement by way of the attachment of linkage arm 42 with the enlarged segment 43 draws linkage arm 42 rearward. This in turn causes front arm 44 to pivot about fixed pivot pin 45 (in the counter-clockwise direction as illustrated in Figure 2) to lower front wheel 13a.

The same linkage operation occurs in the mirror image at the other end of pivot shaft 33 with the pair of front and rear wheels not shown in Figure 2.

In the preferred embodiment both handles 32 are used to evenly control the height of the blades and thereby the cutting depth. Once the depth appears to be level, small adjustments can be independently made on each handle to correct any minor misalignments, thereby ensuring an even cutting depth across the width of the machine.

Accordingly, the effective height of the frame 11, and hence the cutting blades, relative to the wheel can be adjusted by simply a turn of the handles.

As mentioned earlier, it is possible to construct the machine with only one handle operating the pivot shaft. This would require compensatory changes to the construction and strength of the linkage mechanism of the scarifier in order to avoid twisting and damage to the pivot shaft 33. For example, one handle would be sufficient where the pivoting shaft is shorter than that illustrated herein or where the pivoting shaft is made from a thicker gauge metal.

The scarifier illustrated in Figure 1 shows the gear box 14 mounted off-centre on the frame. This can create a weight imbalance which can impact scarifier performance. Counterweights can be attached to the frame to counterbalance the weight of the gear box.

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A pedestrian scarifier 20 is illustrated in Figures 3 to 7 and operates in a substantially similar manner to the tractor mounted scarifier but the difference being that  
5 the driving means is a two-stroke or a four-stroke engine 49 similar to that of a motor mower, mounted onto the scarifier itself.

In known pedestrian scarifiers the cutting depth is  
10 adjusted by raising and lowering the entire machine relative to the wheels, including the motor. In transit, the entire machine is lifted off the ground relative to the wheels to prevent the blades touching the ground. With the present pedestrian scarifier only the rotor  
15 housing 21 is lowered, the main scarifier frame 51 remaining at a constant height above the ground supported on scarifier wheels 56. The rotor housing 21 has its own set of rotor support wheels 55.

20 Extending diagonally upward from frame 51 is a handle assembly 54 to push and direct the pedestrian scarifier. The rotor housing 21 is pivotally mounted on the scarifier frame 51. As best illustrated in Figures 5 and 6, rotor wheels 55 are mounted alongside the rotor housing and  
25 substantially in line with blades 50 supported on rotor shaft 25. Rotor wheels 55 provide support to the blades during operation. Rotor wheels 55 are supported by rotor wheel arms 57 which are pivotable at rotor wheel shaft 53 that extends through rotor housing 21. The wheel shaft 53  
30 extends through to the other side of the rotor housing connecting to the rotor wheel on the other side, such that both wheels pivot from the same point. Rotor wheels 55 pivot at wheel shaft 53 relative to the rotor housing 21 to enable the cutting depth to be adjusted.

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A motor driven shaft 22 drives first belt 23 to drive intermediate shaft 24 which in turn drives rotor shaft 25

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by way of a second belt 26. A series of circular rotor blades 50 are mounted on rotor shaft 25.

5 The rotor housing 21 is mounted on scarifier frame 51 to pivot about intermediate shaft 24. A control linkage 27 mounted to the frame 51 controls the raising and lowering movement of rotor housing 21, with the movement being controlled by lever 52 on the handle assembly 54 of scarifier 20.

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To illustrate this, Figure 5 shows rotor housing 21 in the raised position adopted when transporting or turning the scarifier. Pushing lever 52 downward causes the control linkage 27 to lower rotor housing 21 into the lowered position illustrated in Figure 6 used when operating the scarifier.

By locating the pivot point of rotor housing 21 about intermediate shaft 24 belt tension can be constantly maintained, by tension roller 38, while raising and lowering the blades thereby preventing any slackening or stretching of the belt. Accordingly, slippage on the belt and loss of drive to the blades avoided.

25 The degree of pivot of rotor wheels 55, on wheel shaft 53 is variable so that the height of the rotor wheels relative to the blades 50 can be adjusted to achieve the desired cutting depth of the blades 50. The desired depth of the rotor wheels is set by way of a rotor housing adjustment mechanism 60.

Rotor housing adjustment mechanism 60 adjusts the relative height of the blades 50 to the rotor wheels 55. Figure 4 and, in particular, Figure 7 illustrate mechanism 60.

35 Adjustment mechanism 60 operates on a similar principle to the adjustment linkage mechanism 31 used for the tractor mounted scarifier 10 described earlier. Rotor housing 21

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supporting rotor blades 50 and rotor wheels 55 is pivotally mounted to the main scarifier frame 51 at intermediate shaft 24. The weight of the rotor housing and the components it supports causes the rotor housing 21 to bias towards the ground.

The degree of pivot of rotor wheels 55 is reliant on adjustment mechanism 60. Specifically, a user can adjust the pivoting angle of wheels 55 by way of screw handle 62 on adjustment mechanism 60.

Rotor wheels 55 are mounted by way of arms 57 to pivot at wheel shaft 53. Rotor wheels 55 tend to fold at a large angle of inclination to the ground under the weight of the rotor housing. Adjustment mechanism 60 counter-acts this tendency to fold and lifts rotor housing 21 straightening arms 57 of rotor wheels 55. A stop (not shown) prevents arms 57 from straightening past a certain point. The ends of rotor shaft 25 protruding from rotor housing 21 stops the arms 57 from folding beyond a certain point.

Adjustment mechanism 60 includes screw handle 62 which extends through bore 64 supported on top of bore plate 65. Screw handle 62 rotates to extend through bore 64 and bias against a pivoting reaction plate 66. Reaction plate 66 is supported on a reaction arm 67 and pivots on adjustment mechanism shaft 68.

Fixed to reaction arm 67 and extending at a fixed angle thereto is strut 70 carrying a strut roller 72 at its end. Strut roller 72 is disposed to roll between a lip 74, defined by the underside of bore plate 65, and rotor wheel arm 57. Lip 74 and rotor wheel arm 57 are relatively angled such that the further screw handle 62 biases against reaction plate 66 the further strut roller 72 will wedge itself between lip 74 and wheel arm 57 thereby causing wheel arm 57 to rotate against the weight of the

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rotor housing 21 and in effect lift the rotor housing 21. Hence, blades 50 are also lifted with respect to rotor wheels 55.

- 5 Loosening screw handle 60 from reaction plate 66 causes strut roller 72 to gradually release its wedging force between lip 74 and wheel arm 57 and roll downward of lip 74 thereby causing wheel arm 57 to pivot at a greater inclination to the ground. This in turn lowers rotor  
10 housing 21 closer to the ground.

- The adjustment mechanism 60 simultaneously adjusts the rotor wheels 55 at both ends of rotor housing 21. Adjustment mechanism shaft 68 extends across the length of  
15 rotor housing 21 to securely support at both its ends similar adjustment mechanisms 60 as illustrated by the right side and left side perspective views in Figures 3 and 4 respectively. However, only one adjustment mechanism 60 is provided with a screw handle 62.

- 20 In the drawings the screw handle is located on the left side of the pedestrian scarifier (Figures 4 and 7). Operation of the screw handle 62 causes shaft 68, to which pivoting reaction arm 67 is fixed, to rotate thereby  
25 causing the mirror reaction arm 67 at the right side of the rotor housing to also rotate in the same direction and match the movements of strut rollers 72 to raise or lower rotor housing 21.

- 30 Accordingly, in using the pedestrian scarifier 20 the correct height adjustment of the blades 50 relative to the rotor wheels 55 is estimated by manipulating rotor housing adjustment mechanism 60 while the rotor housing 21 is in a raised position. A depth adjustment indicator (not shown)  
35 may be provided on the housing adjustment mechanism 60 to guide the user as to the depth of the blades in the ground. The rotor shaft is then engaged to start the

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blades 50 spinning. Lever 52 is then pivoted around to drop the rotor housing 21, by way of control linkage 27, to the ground with blades 50 engaging the ground. A test run is usually recommended to check that the depth of the blades is correct and adjustment of the blade height is made as necessary.

Since rotor wheels 55 are substantially in line with the rotor shaft 25, wheels 55 move in unison with the blades keeping them at a constant cutting depth over any type of surface, and even on undulating surfaces. The rotor housing moves with the rotor wheels 55.

A drive lever (not shown) incorporated into the handle 54 uses a hydrostatic drive to drive the driving wheels 56 of the pedestrian scarifier at variable speeds.

In both the tractor mounted and pedestrian scarifiers the blades are arranged such that the blade tips are out of phase with the blade tips on each adjacent side. This means that during operation the blade tips cut into the turf in sequence providing an overall superior scarified surface.

Both embodiments illustrate a scarifier mounted on four wheels. However, it is understood that more or less wheels could be effectively used with some minor alterations to the frame and/or linkages.

The present scarifiers enable easy adjustment of the cutting depth using minimal adjustment controls and without the need for any adjusting tools. The scarifiers, whether tractor mounted or pushed, enjoy smooth and controlled scarifying of turf at constant depths and the blades can be easily unengaged when not in use.

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It will be understood to persons skilled in the art of the invention that many modifications may be made without departing from the spirit and scope of the invention.